Sputtering of Nanoparticles in/on Ionic Liquids

Evert Vanecht, Jin Won Seo†, Jan Fransaer†, Koen Binnemans**

**Laboratory of Coordination Chemistry, Department of Chemistry, KULeuven, Belgium; †Department of Metallurgy and Material Engineering, KULeuven, Belgium*

Small nanoparticles (NPs) exhibit size-dependent photonic and electronic properties that are of interest for applications such as biosensors, catalysis, optics, and electronics. In most cases of nanoparticle preparation in solution the resulting suspension contains byproducts, remaining substrates, and stabilizing agents. This can be obstructive for utilization of the prepared nanoparticles (e.g. catalysis).
The extremely low vapor pressure of ionic liquids (ILs) has enabled their use under high vacuum conditions. Torimoto et al. were the first to report a clean method to synthesize gold nanoparticles in ionic liquids using the sputter deposition technique.[1,2]
We conducted further experiments to explore this new synthesis method and the results are analyzed critically. Gold NPs are used as model system. The influence of experimental parameters on shape, size and size-distribution of the NPs is investigated. The experimental parameters include: target composition, background pressure, applied voltage, distance between target and substrate, sputter time, and composition of the IL. The stability of the IL/NPs sols is also examined and ways to improve stability are proposed. We tried to elucidate the mechanism of particle formation during sputtering on an IL. A hypothesis is stated.
Characterization of the metal nanoparticles is done by transmission electron microscopy (TEM). UV-Visible absorption spectroscopy is used to detect the surface plasmon resonance absorption (SPR) band. Figure 1 shows some typical TEM images of an IL containing gold NPs after sputtering.

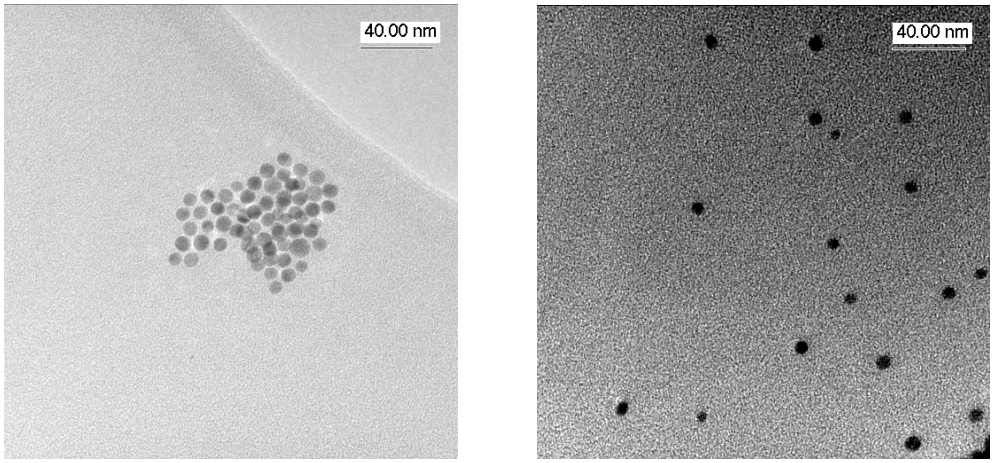

Figure 1: TEM image of Au NPs in $[C_1C_4Im][N(CN)_2]$

1. Torimoto, T.; Okazaki, K. i.; Kiyama, T.; Hirahara, K.; Tanaka, N.; Kuwabata, S. *Applied Physics Letters* **2006,** *89* (24), 243117-1-243117/3.
2. Okazaki, K. i.; Kiyama, T.; Hirahara, K.; Tanaka, N.; Kuwabata, S.; Torimoto, T. *Chem. Commun. (Cambridge, U. K.)* **2008,** (6), 691-693.